Problem of the Day

2015.Jul.05

Problem of the Day

The influent flow averages 960,000 gpd. Over 25 days, the grit bin fills up half way. It is 10 feet long, 8 feet wide and 6 feet tall. Calculate the grit production in ft^3/MG.

Introduction

Grit removal in wastewater treatment plants is extremely important. I worked with a nitrifying/denitrifying wastewater treatment plant in the California desert once that had no grit removal. Really, in the desert? Think there's much sand? Besides the usual problems with plugging and abrasion you'd expect in a plant with no grit removal, this plant had another interesting consequence you'd never expect: The operators had to keep the aeration rate so high in the aeration basins to keep the grit in suspension, that the dissolved oxygen concentration in the mixed liquor recycle flow to the anoxic zone was so high it prevented dentrification from occurring.

Solution

The units asked for in the answer are ft^3/Mgal. These units are put between heavy vertical lines, as always, followed by an equals sign and the blank solution bridge.

Problem of the Day: The influent flow averages 960,000 gpd. Over 25 days, the grit bin fills up half way. It is 10 feet long, 8 feet wide and 6 feet tall. Calculate the grit production in ft^3/MG.

$$\left| \frac{ft^3}{Mgal} \right| = \frac{\qquad}{\qquad}$$

The solution bridge is started by calculating the volume of the accumulated grit. This is just the length times the width times the depth of the grit bin. The only trick here is that it has to be divided by two because the bin is only filled "half way."

$$\left| \frac{\mathbf{ft^3}}{Mgal} \right| = \left| \frac{10\ \mathbf{ft} \quad 8\ \mathbf{ft} \quad 6\mathbf{ft}}{2} \right| \frac{\qquad}{\qquad}$$

There's probably an equation that is used to find the answer to a question like this, but I just let the units tell me what to do. I see that I have to have Mgal in the denominator, but we don't have an Mgal, so we enter a conversion factor to get the units we want, where we want them.

$$\left| \frac{\mathbf{ft^3}}{\mathbf{Mgal}} \right| = \left| \frac{10\ \mathbf{ft} \quad 8\ \mathbf{ft} \quad 6\mathbf{ft} \quad 10^6\ gal}{2 \quad \mathbf{Mgal}} \right| \frac{\qquad}{\qquad}$$

We have the units on the solution bridge that we need in the answer, but we still have unwanted units as well. To get rid of the gal in the numerator, we divided by the flow.

$$\left| \frac{\mathbf{ft^3}}{\mathbf{Mgal}} \right| = \left| \frac{10\ \mathbf{ft} \quad 8\ \mathbf{ft} \quad 6\mathbf{ft} \quad 10^6\ \cancel{gal} \quad d}{2 \quad \mathbf{Mgal} \quad 960{,}000\ \cancel{gal}} \right| \frac{\qquad}{\qquad}$$

That got rid of gal, but now we have d we have to cancel. We do so by dividing by how many days it took to fill the bin half way so the units cancel, numerator and denominator.

$$\left| \frac{\mathbf{ft^3}}{\mathbf{Mgal}} \right| = \left| \frac{10\ \mathbf{ft} \quad 8\ \mathbf{ft} \quad 6\mathbf{ft} \quad 10^6\ \cancel{gal} \quad \cancel{d}}{2 \quad \mathbf{Mgal} \quad 960{,}000\ \cancel{gal} \quad 25\ \cancel{d}} \right|$$

Since all the units have canceled except those needed in the answer, we know the solution bridge is complete. The arithmetic gives the answer.

Problem of the Day: The influent flow averages 960,000 gpd. Over 25 days, the grit bin fills up half way. It is 10 feet long, 8 feet wide and 6 feet tall. Calculate the grit production in ft^3/MG.

ft^3	=	10 **ft**	8 **ft**	6**ft**	10^6 ~~gal~~	~~d~~	
Mgal		2			**Mgal**	960,000 ~~gal~~	25 ~~d~~

10 x 8 x 6 x 1,000,000 ÷ 2 ÷ 960,000 ÷ 25 = **<u>10.0 ft^3/Mgal</u>**.

Discussion

This EPA wastewater technology fact sheet gives the grit production for eight wastewater treatment plants ranging from 0.41 to 10.5 ft^3/Mgal. Our answer is on the high end of this range, but in the range nonetheless.

An interesting story: a student in one of WWTT's Operator Certification and Math Review classes insisted on always expressing flow, no matter what units it was given in, as MGD. So he would probably have converted 960,000 gpd to 0.96 MGD "in his head." What he then did was entered 0.96 MGD in the denominator. Then, to get days (d) to cancel, he **multiplied** rather than divided by 25 d. This is why it is so important to express units exactly like you say them, "0.96 million gallons **per** day." This is also why you will never see WWTT use units like MGD, cfs, gpm and gpd even though operators see these units all the time in study guides and on certification exams.

Happy calculating! Let us know, by leaving a comment, if you want us to do a specific problem, if you see a mistake, or if you have a question on any of the Problems of the Day you are looking at.